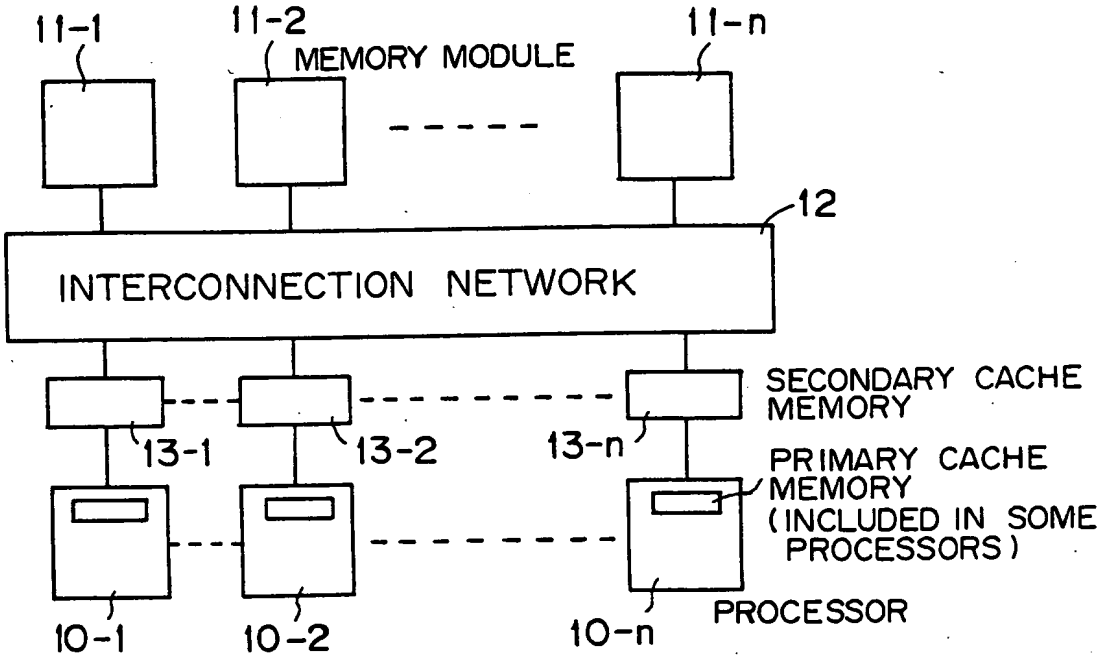

11-1
11-2
MEMORY MODULE
11-n
12
INTERCONNECTION NETWORK
SECONDARY CACHE MEMORY
13-1
13-2
13-n
PRIMARY CACHE MEMORY (INCLUDED IN SOME PROCESSORS)
PROCESSOR
10-1
10-2
10-n

FIG. 1

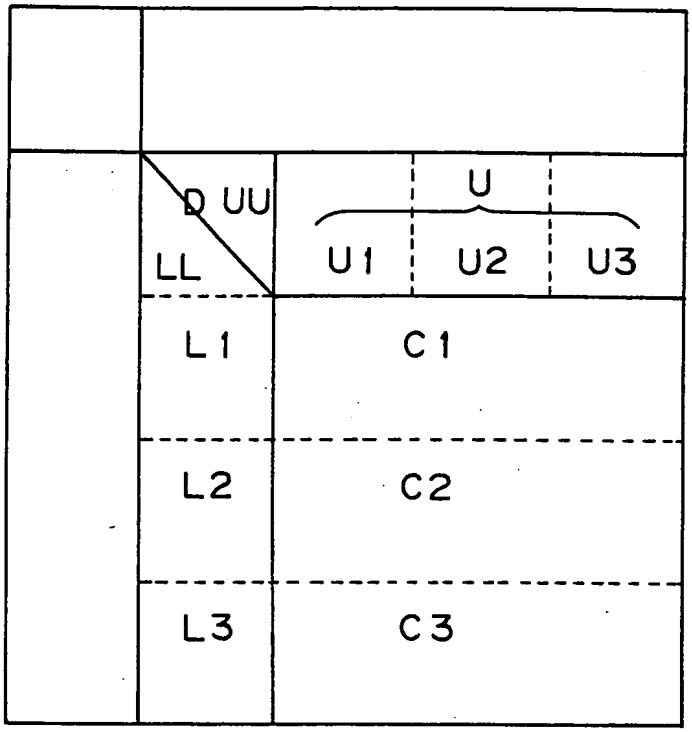


FIG. 2

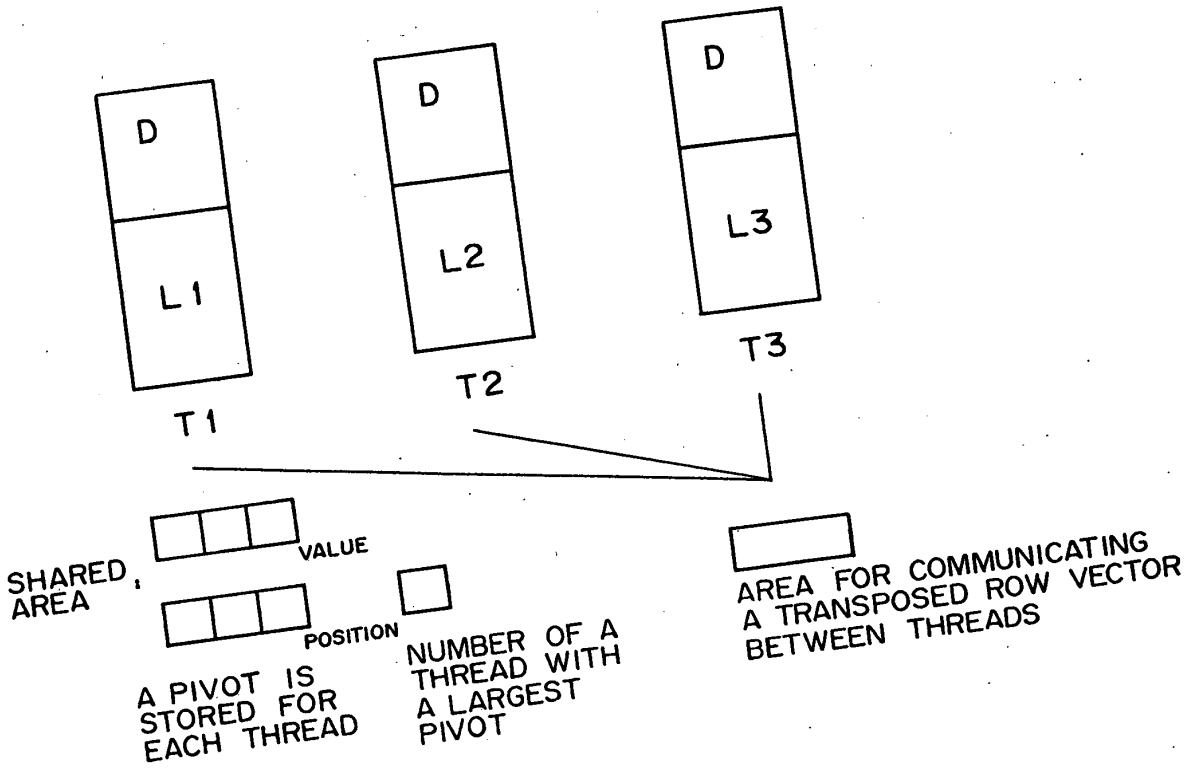


FIG. 3

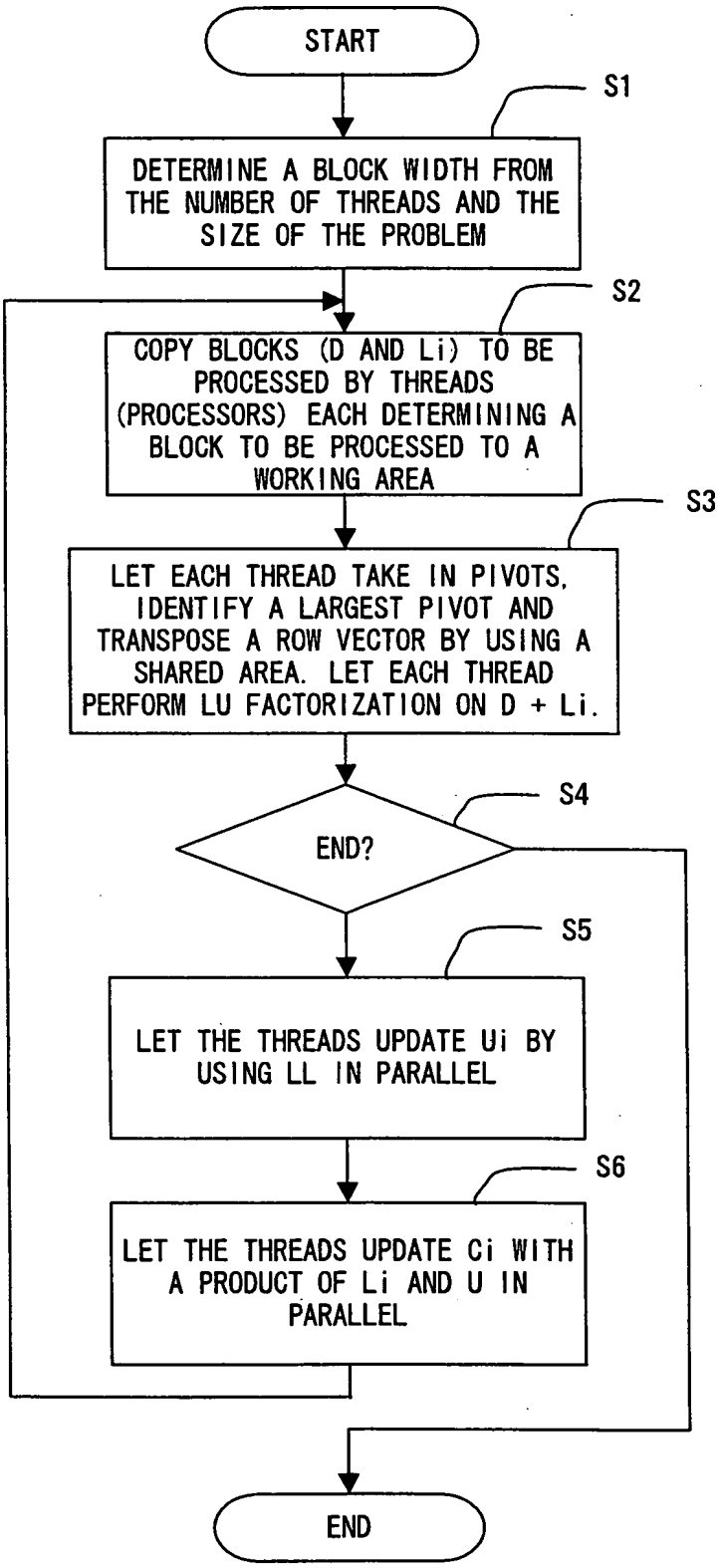

START
S1
DETERMINE A BLOCK WIDTH FROM THE NUMBER OF THREADS AND THE SIZE OF THE PROBLEM
S2
COPY BLOCKS (D AND Li) TO BE PROCESSED BY THREADS (PROCESSORS) EACH DETERMINING A BLOCK TO BE PROCESSED TO A WORKING AREA
S3
LET EACH THREAD TAKE IN PIVOTS, IDENTIFY A LARGEST PIVOT AND TRANSPOSE A ROW VECTOR BY USING A SHARED AREA. LET EACH THREAD PERFORM LU FACTORIZATION ON D + Li.
S4
END?
S5
LET THE THREADS UPDATE Ui BY USING LL IN PARALLEL
S6
LET THE THREADS UPDATE Ci WITH A PRODUCT OF Li AND U IN PARALLEL
END

FIG. 4

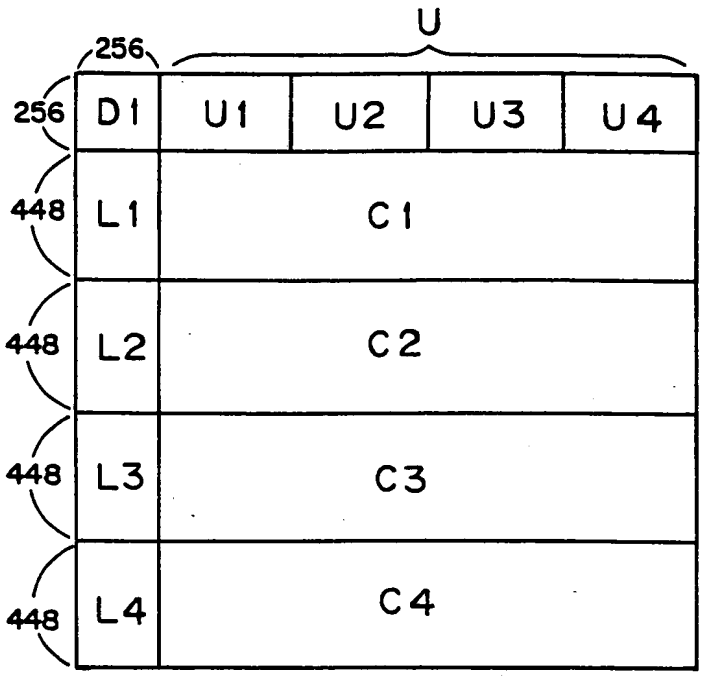


FIG. 5

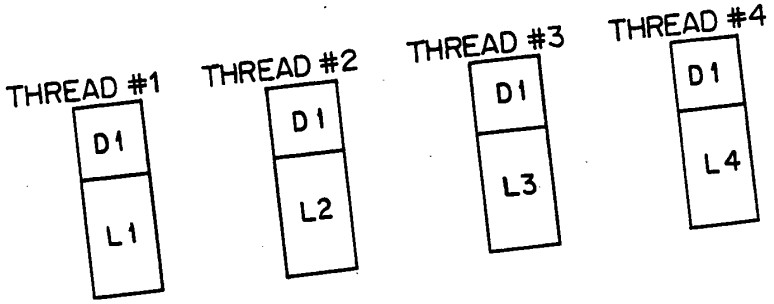
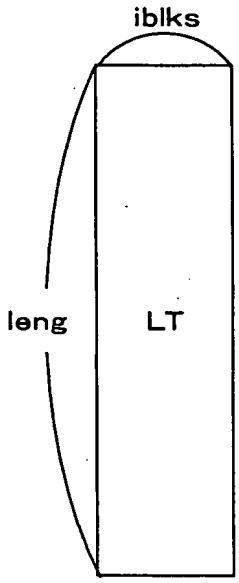


FIG. 6




```
DO  i=1, iblks
  TMP=0.0  DO;jj=0
DO  j=i, leng
  IF(ABS  LT(j, i)), GT  , TMP)THEN
  TMP=ABS(LT(j, i))
  jj=j
  ENDIF
ENDDO
```

(1)

```
IF(jj, GT, i)  THEN
    DO  k=1, iblks
    TMPX=LT(i, k)
    LT(i, k)=LT(jj, k)
    LT(jj, k)=TMPX
  ENDDO
END  IF
```

(2)

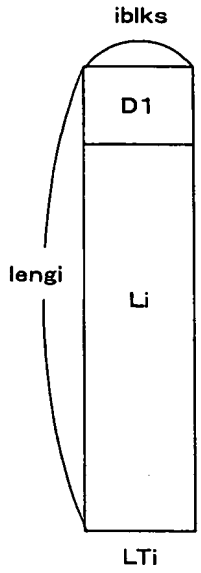
```
DO  k=i+1, iblks
    LT(i, k)=LT(i, k)/LT(i, i)
ENDDO

DO  k=i+1, iblks
DO  l=i+1, leng
    LT(l, k)=LT(l, k)−LT(l, i)×LT(i, k)
ENDDO
ENDDO

ENDDO
```

(3)

FIG. 7




```
DO  i=1, iblks
 TMP=0.0  DO;jj=0
DO  j=1, lengi
 IF(ABS  LTi(j, i)), GT  , TMP)THEN
 TMP=ABS(LTi(j, i))                                              (4)
 jj=i
 ENDIF
ENDDO
pivpot(#THREAD)=jj
(#THREAD IS A THREAD NUMBER. IN THE
CASE OF PARALLEL PROCESSING BY 4
THREADS, #THREAD IS PRESCRIBED AS                                (5)
1,2,3 AND 4.)

BARRIER SYNCHRONIZATION
 iF(#THREAD, EQ, 1)
    jx=0;GPIVOT=0
 DO  ix=1, 4
    IF(pivot(ix), GT, jx. AND, PIVOT(ix). GT. iblks)GPIVOT=ix
          (THE NUMBER OF A THREAD HAVING A LARGEST NUMBER)       (6)

 ENDDO
END  IF
BARRIER SYNCHRONIZATION

IF(#THREAD, EQ, GPIVOT)THEN
   IF(jj, GT, i)THEN
   DO  ix=1, iblks
   ROW(ix)=LTi(jj, ix)                                           (7)
 ENDDO
END  IF
BARRIER SYNCHRONIZATION
IF(GPIVOT, EQ, 0)THEN
   IF(jj, GT, i)THEN                  <- SINCE TRASPOSITION HAS
     DO  i=1, iblks,                     BEEN CARRIED OUT IN AN IP,
        TMPW=LTi(i, ix)                  THE THREADS EXECUTE THE
        LTi(i, ix)=LTi(jj, ix)           PROCESSING IN PARALLEL
        LTi(jj, ix)=TMPW
      ENDDO
     END  IF
ELSE
   IF(#THREAD, EQ, GPIVOT)THEN                                   (8)
     DO  ix=1, iblks
        LTi(jj, ix)=LTi(i, ix)
        LTi(i, ix)=ROW(ix)
   ENDDO
  ELSE
     DO  ix=1, iblks
     LTi(i, ix)=ROW(ix)
     ENDDO
  ENDIF


   DO  k=i+1, iblks,
         LTi(i, k)=LTi(i, k)/LT(i, i)                            (9)
   ENDDO

   DO  k=i+1, iblks
   DO  l=i+1, lengi
       LTi(l, k)=LTi(l, k)-LTi(l, i)×LTi(i, k)                   (10)
   ENDDO
   ENDDO

   ENDDO
```

FIG. 8

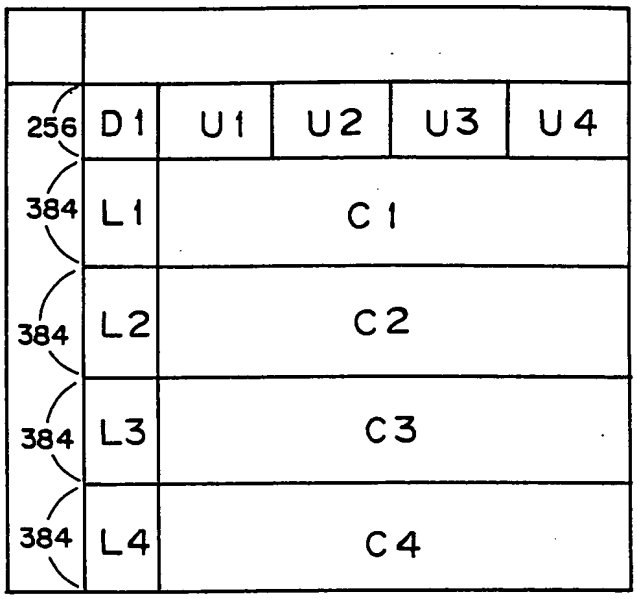


FIG. 9

```
subroutine  LU(LTi, k, iblks, ist, nwid)
   (WHERE LTi IS USED BY THREADS FOR STORING (D1+Li),
    k IS THE SIZE OF THE FIRST ONE DIMENSION OF LTi,
    iblks IS THE BLOCK WIDTH,
    ist IS A POSITION TO START THE Lu FACTORIZATION AND
    nwid IS THE WIDTH OF AN OBJECT SUBJECTED TO THE Lu FACTORIZATION)
 IF(nwid, eq, 8), Then(A WIDTH OF 8 IS A MINIMUM).

LTi(ist:k, ist, ist+nwid−1) IS SUBJECTED TO THE LU FACTORIZATION IN
PARALLEL.
   HERE, THE PARTS (4) TO (10) OF FIG.9 ARE EXECUTED.
    IN THIS CASE, THE ROW-TRANSPOSING UNIT TRANSPOSES
   LTi(i, 1, iblks) AT THE LENGTH iblk.
else
   call  LU(LTi, k, iblks, ist, nwid/2)
   call  TRS( )
   UPDATE LTi(ist:ist+nwid/2−1, ist+nwid/2:ist+nwid). BY USING A
LOWER-TRIANGULAR MATRIX LL OF LTi(ist:ist+nwid/2−1, ist:ist+nwid/2
−1), UPDATE IT BY MULTIPLYING IT BY LL+ FROM THE LEFT.

   call  MM( )
   LTi(ist+nwid/2:k, ist+nwid/2:ist+nwid)
   =LTi(ist+nwid/2:k, ist+nwid/2:ist+nwid)
    −LTi(ist+nwid/2:k, ist:ist+nwid/2−1) ×
     LTi(ist:ist+nwid/2−1, ist+nwid/2:ist+nwid)

Barrier SYNCHRONIZATION
call  LU(LTi, k, iblks, ist+nwid/2, nwid/2
end  if
   return
   end  subroutine
```

FIG. 10

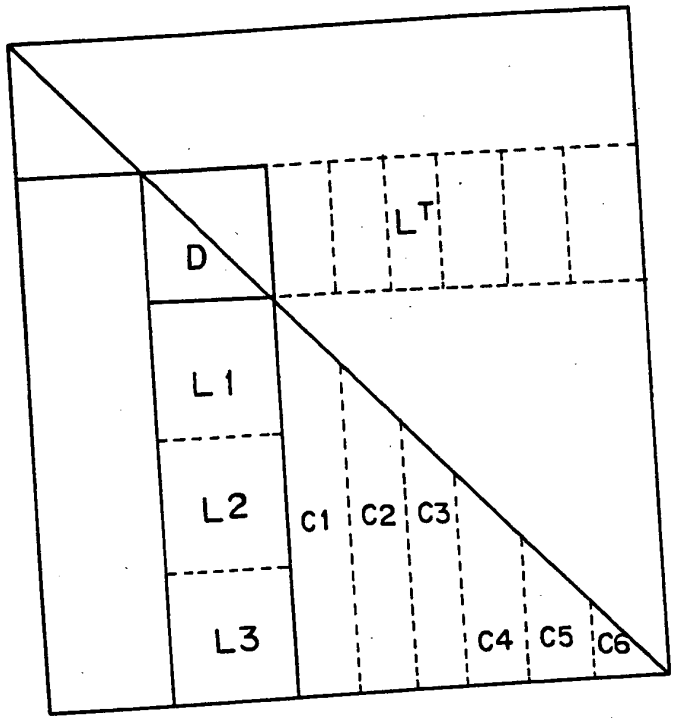


FIG. 11

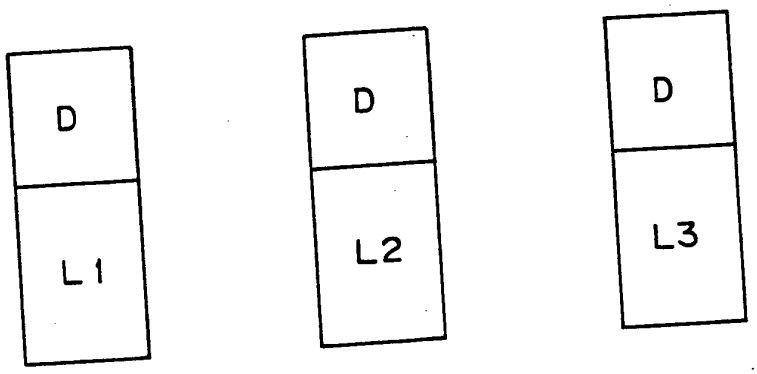


FIG. 12

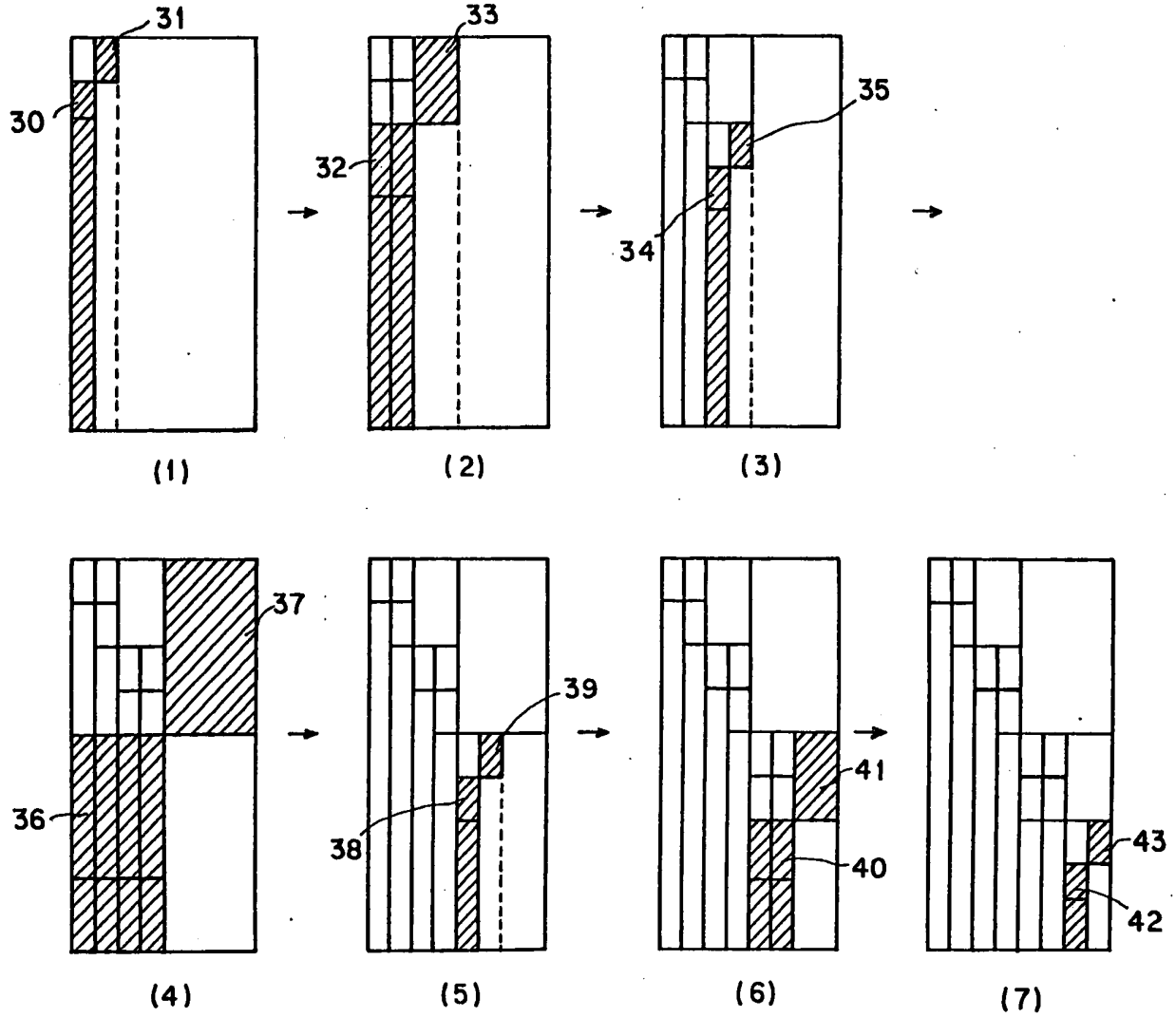


FIG. 13

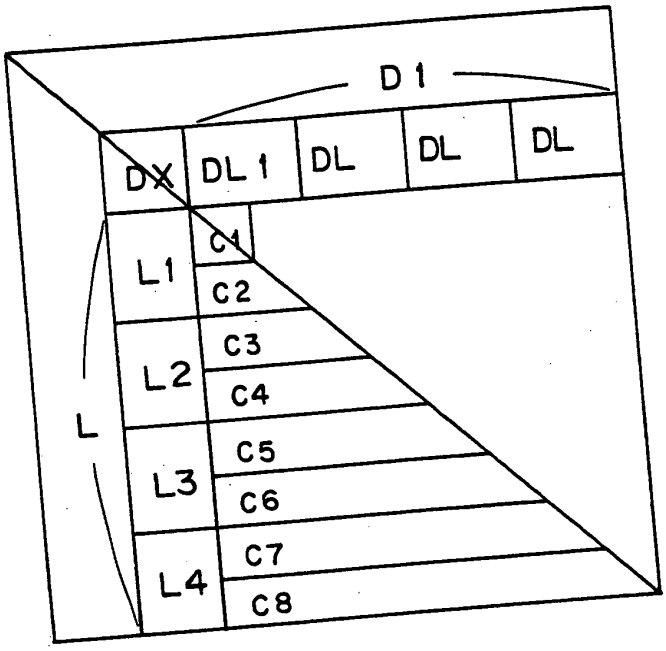


FIG. 14

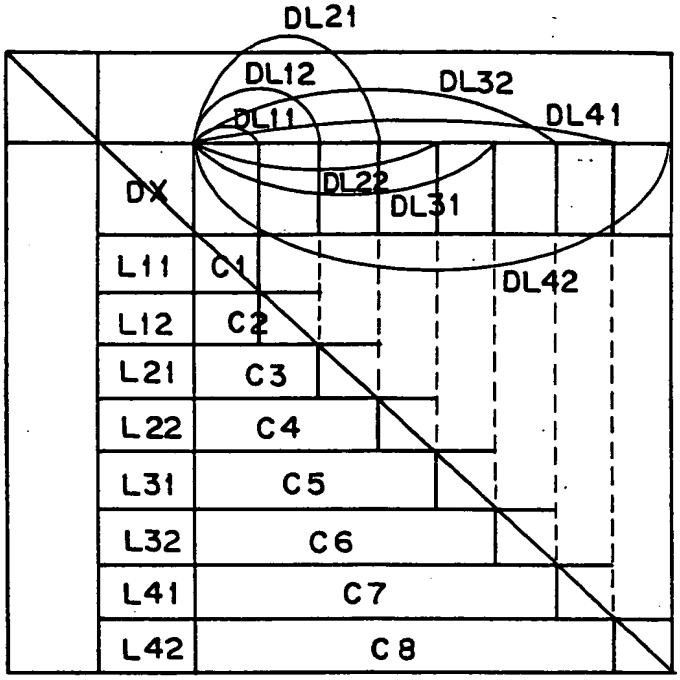

DL21
DL12
DL32
DL11
DL41
DX
DL22
DL31
L11
C1
DL42
L12
C2
L21
C3
L22
C4
L31
C5
L32
C6
L41
C7
L42
C8

FIG. 15

```
subroutine  LTD(LTi, k, iblks, ist, nwid)
 IF(nwid, EQ, 8)THEN    (THE WIDTH OF 8 IS THE MINIMUM)
  DOi=ist, ist+7
   DOj=i+1, ist+7
    LTi(i, j)=LTi(j, i)
    LTi(j, i)=LTi(j, i)/LTi(i, i)
   ENDDO
   DO  jy=i+1, ist+7
   DO  jx=jx, ist+7
    LTi(jx, jy)=LTi(jx, jy)-LTi(jx, i)×LTi(i, jy)
   ENDDO
   ENDDO                                                    (20)

  UPDATE LTi(LTi(ist+8;k, ist:ist+7).
  SINCE DL^T IS INCLUDED IN THE UPPER TRIANGLE OF
   LTi(LTi(ist:ist+7, ist:ist+7), UPDATE (PL^T)^-1 FROM THE RIGHT.

  ELSE
  call  LDL(LTi, k, iblks, ist, nwid/2)

  COPY DL^T TO
  ·LTi(ist:ist+nwid/2-1, ist+nwid/2:ist+nwid-1).
  (D IS AN OBJECT ELEMENT OF LTi(ist:ist+nwid/2-1, ist:ist+nwid/2-1)
  AND L IS
  LTi(ist+nwid/2:ist+nwid-1, ist:ist+nwid/2-1),
  TRANSPOSING THIS L^T.)

   ·UPDATE LTi(ist+nwid/2:k, ist+nwid/2:ist+nwid-1).

   LTi(ist+nwid/2:k, ist+nwid/2:ist+nwid-1)
   =LTi(ist:ist+nwid/2:k, ist+nwid/2:ist+nwid-1)-
   LTi(ist+nwid/2:k, ist:ist+nwid-1)×
   LTi(ist:ist+nwid/2-1, ist+nwid/2;ist+nwid-1)

   CALL  LDL  (LTi, k, iblks, ist+nwid/2, nwid/2)

  ENDIF

   RETURN

   END
```

FIG. 16